

Groundwater Contamination Containment Evaluation

Proposed Modeling Path Forward

November 05, 2015



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Purpose of Cap Modeling Activities

- Screening evaluation
 - To determine if groundwater plume contaminants can be reliably contained within river sediments by a reactive cap
 - To determine whether the groundwater pathway poses a threat to the selected remedy
- Conditions specific to Rhone Poulenc site will be evaluated versus two PH FS process option capping technologies
 - Reactive cap and significantly augmented reactive cap

Model Description

- Active Cap Layer Model v4.11 is a Microsoft Excel-based capping model developed by Danny Reible of Texas Tech University (<https://www.depts.ttu.edu/ceweb/groups/reiblesgroup/downloads.html>).
- Allows for the simulation of a contaminated sediment bed, an active cap layer, and a sand overlay (“conventional cap layer”).
- Assumes linear adsorption of contaminants, which is often not a valid assumption for activated carbon.
- Still considered appropriate for developing screening level estimates of contaminant concentrations that can be reliably contained.
- The use of analytical models such as CAPSIM is not warranted at this stage of evaluation.

Model Inputs: Contaminants of Concern

- Chlorobenzene and DDx were selected as the modeled contaminants
 - Represent varied chemical properties, with chlorobenzene being more mobile
 - Are known to be present in conjunction with other contaminants at the Site
- Model input contaminant concentrations from RP-07-84 and RP-14-11 sample locations were selected
 - Provide highest chlorobenzene and DDx concentrations in the most recent year sampled
 - There are no non-detects of the modeled contaminants at these locations

Model Inputs:

Site-specific Concentration Information

Contaminant	Well ID	Matrix for contaminant Concentration	Contaminant Concentration	Contaminant Porewater Concentration used as Model Input
Chlorobenzene	RP-07-84 (September 2007)	GW	140 ug/L	140 ug/L
DDx	RP-14-11 (January 2010)	GW	13.1 ug/L	13.1 ug/L

- Conservatively assume that no additional partitioning of contaminants occurs during transport from the upland source to the sediments
- Conservatively assume source concentrations are constant
- Therefore, porewater concentrations are assumed to be the same as groundwater concentrations

Model Inputs:

Chemical Property Information

Contaminant	log Kow (L/kg)	Koc (L/kg)	Water Diffusivity (cm ² /s)
Chlorobenzene	2.84	456	9.48E-06
DDE	6.51	938,700	4.76E-06

Values obtained from EPA table of contaminant parameters retrieved from <http://www.epa.gov/region9/superfund/prg/>

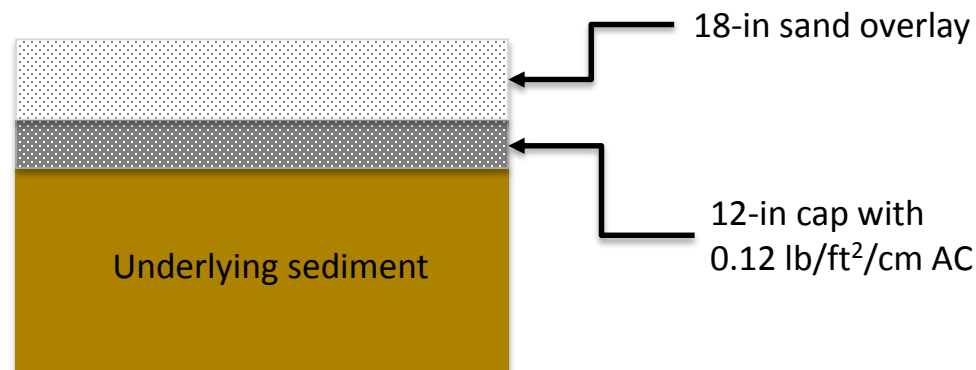
- DDE was chosen as the representative DDx component for determining DDx chemical properties due to its higher mobility
- DDx concentrations are calculated as the summed total of 2,4'-DDT, 4,4'-DDT, 2,4'-DDD, 4,4'-DDD, 2,4'-DDE, and 4,4'DDE
- Model is conservatively set to assume 0 contaminant degradation

Model Inputs: Seepage Velocity

- Model simulations will assume the following seepage velocities:
 - **30 cm/day** was the maximum recorded seepage velocity near Rhone Poulenc
 - **3 cm/day** is the approximate average seepage velocity for the Portland Harbor site
 - **0.3 cm/day** provides a lower bracket for seepage velocities coming out of the sediment bed (as a sensitivity analysis)

Model Inputs: Cap Scenarios

- Cap Scenario 1 – Reactive Cap
 - Cap assumed to have 0.12 lb/ft²/cm activated carbon (AC)
 - Based on a 12-in cap with 50% Aquagate, and Aquagate being 10% AC
 - Equates to 5% AC in the active cap layer
 - Same percentage of carbon used in other Superfund caps (Berry's Creek in New Jersey and Bailey Creek, Fort Eustis in Virginia)
 - Consistent with the modeled reactive cap design in EPA's Portland Harbor FS
 - 18-in sand overlay above active layer



Model Inputs: Cap Scenarios

- Cap Scenario 2 – Significantly Augmented Cap
 - 0.48 lb/ft²/cm activated carbon (AC)
 - Low permeability layer
 - This layer is not physically represented as a separate layer in the model; rather, its effects are represented by limiting seepage velocity to 0.3 cm/day
 - Consistent with the modeled significantly augmented reactive cap design in EPA's Portland Harbor FS

Model Assumptions

- Constant contaminant source in uplands
- No contaminant partitioning from groundwater plume until it reaches the reactive cap
- No contaminant degradation
- No sediment deposition on top of the cap
- No cap consolidation
- No underlying sediment consolidation

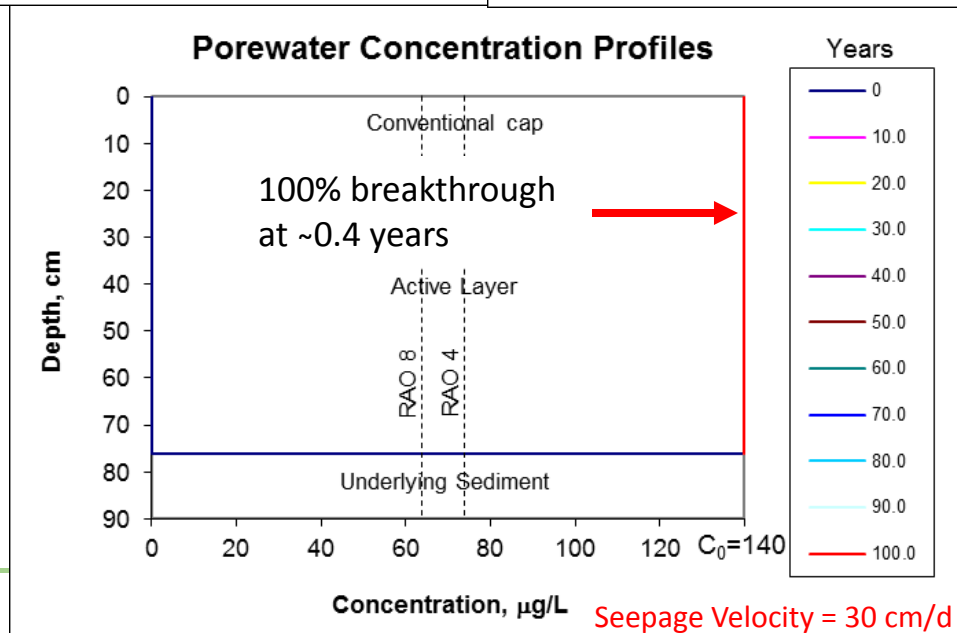
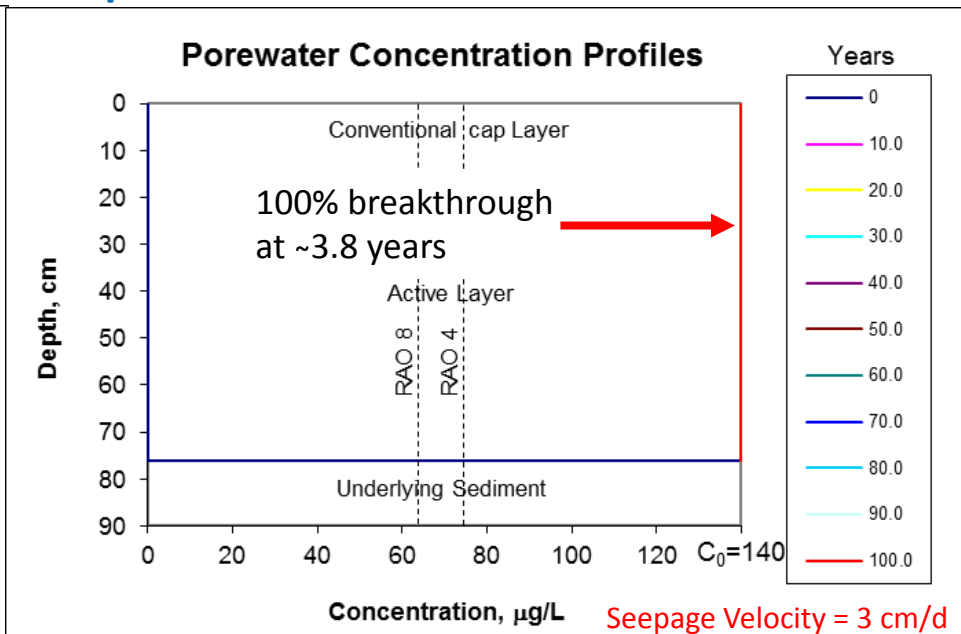
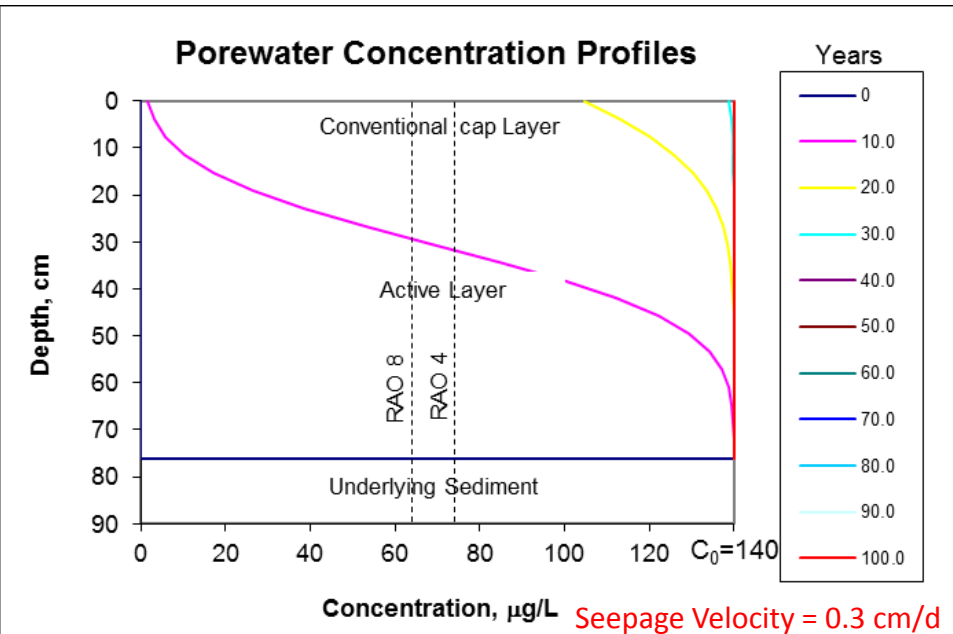
Compliance Points

Contaminant	RAO 4	RAO 8
	Groundwater (µg/L)	Porewater (µg/L)
Chlorobenzene	74	64
DDx	-	0.001

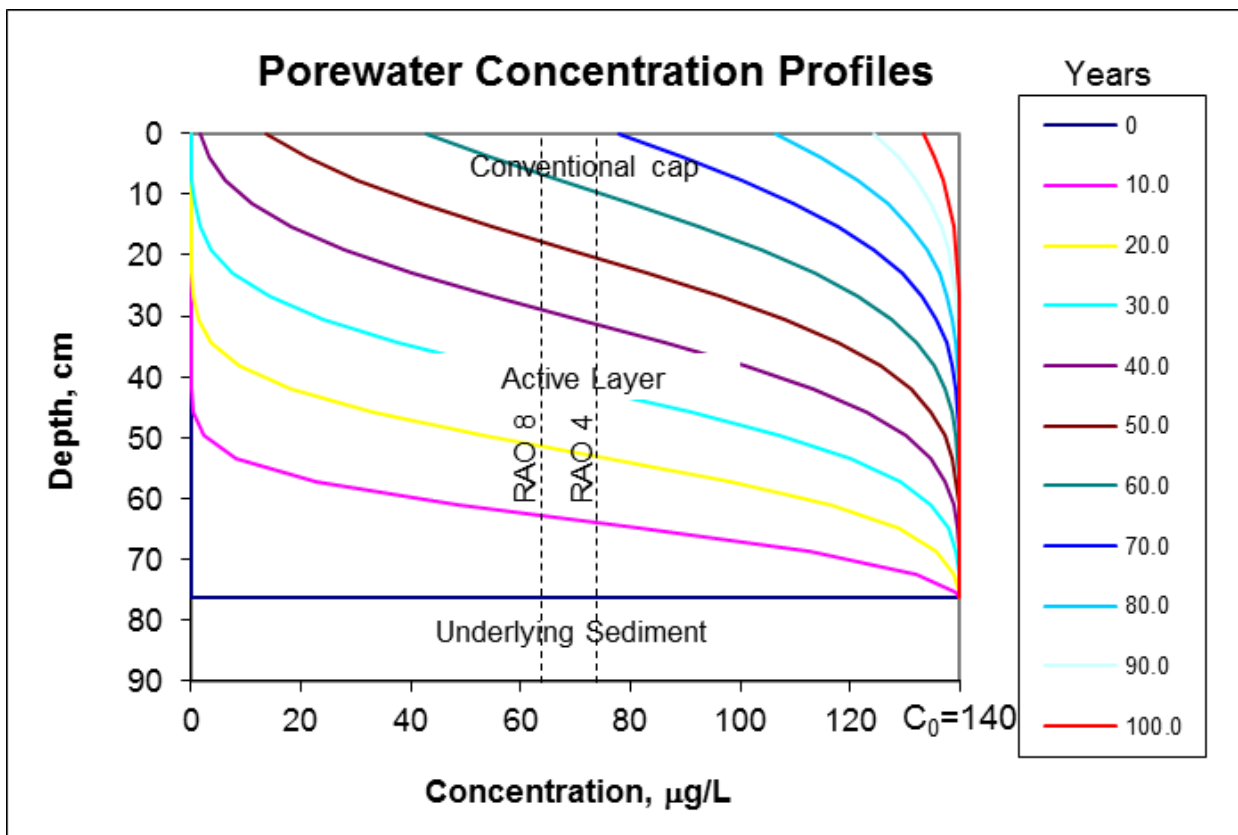
Values obtained from Portland Harbor FS Table 2.2-1

- Contaminant breakthrough indicates that porewater concentration at the sediment cap-surface water interface has reached a concentration above zero
- RAO 4 – Reduce migration of contaminants in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for human exposure.
- RAO 8 – Reduce migration of contaminants in groundwater to sediment and surface water such that levels are acceptable in sediment and surface water for ecological exposure.

Preliminary Model Results: Chlorobenzene Cap Scenario 1

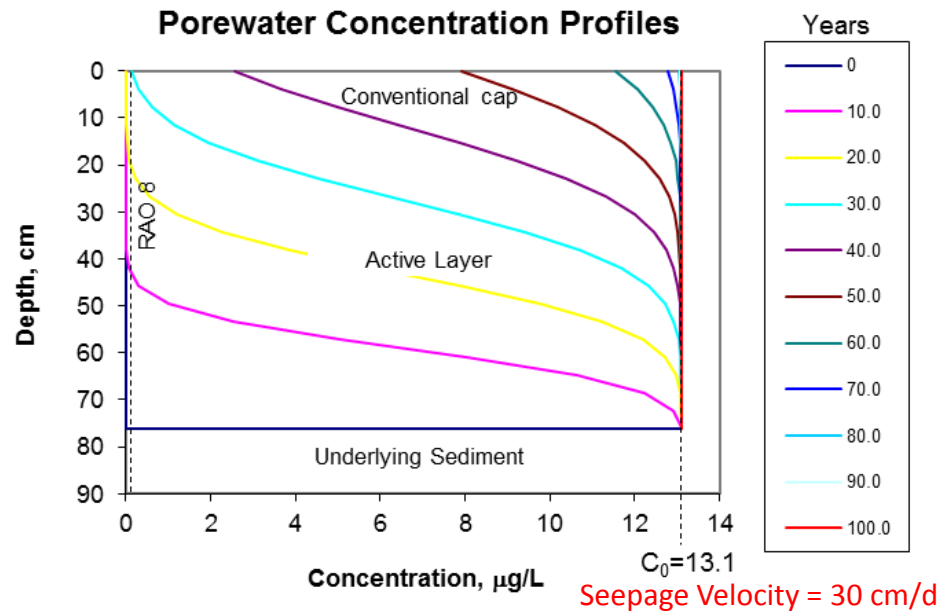
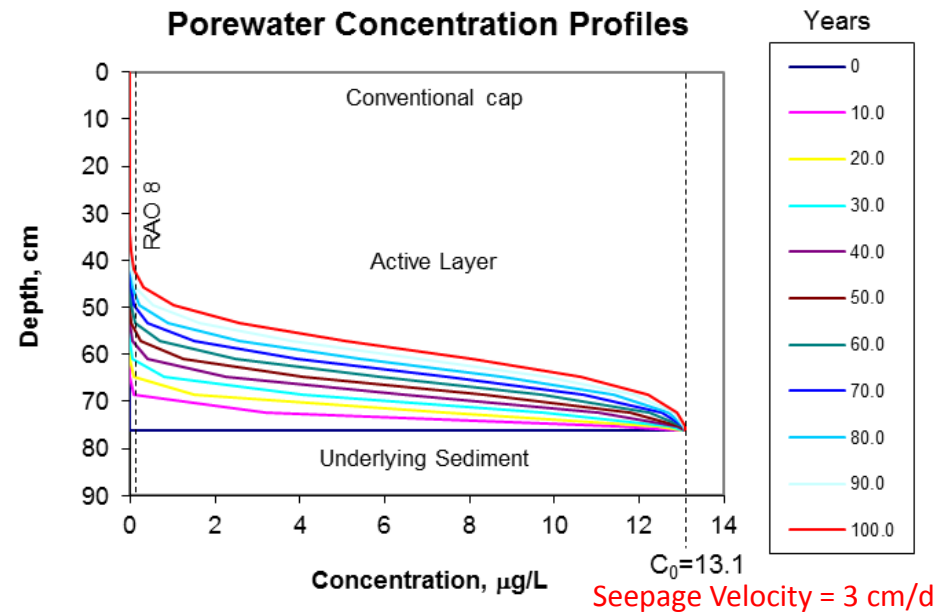
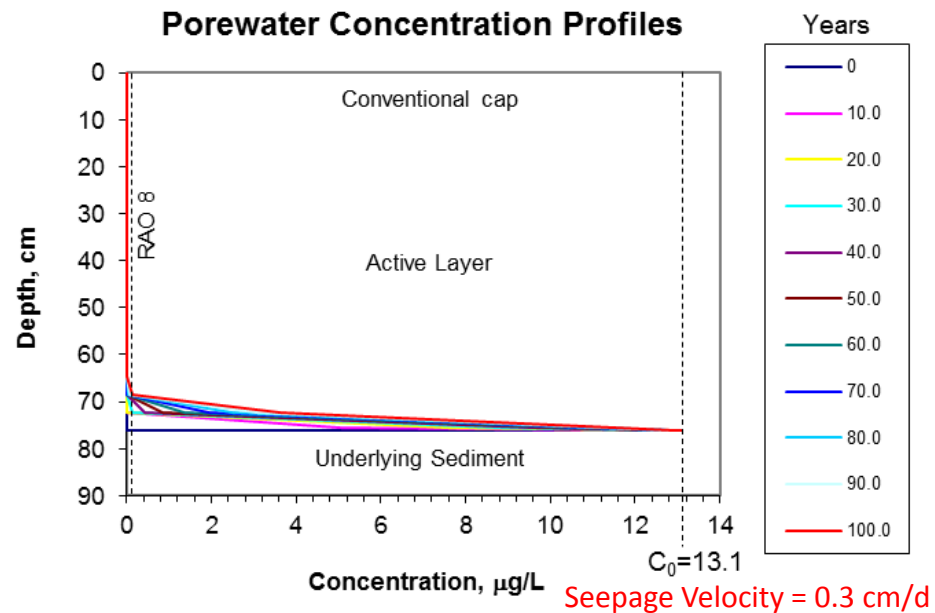


Preliminary Model Results: Chlorobenzene Cap Scenario 2

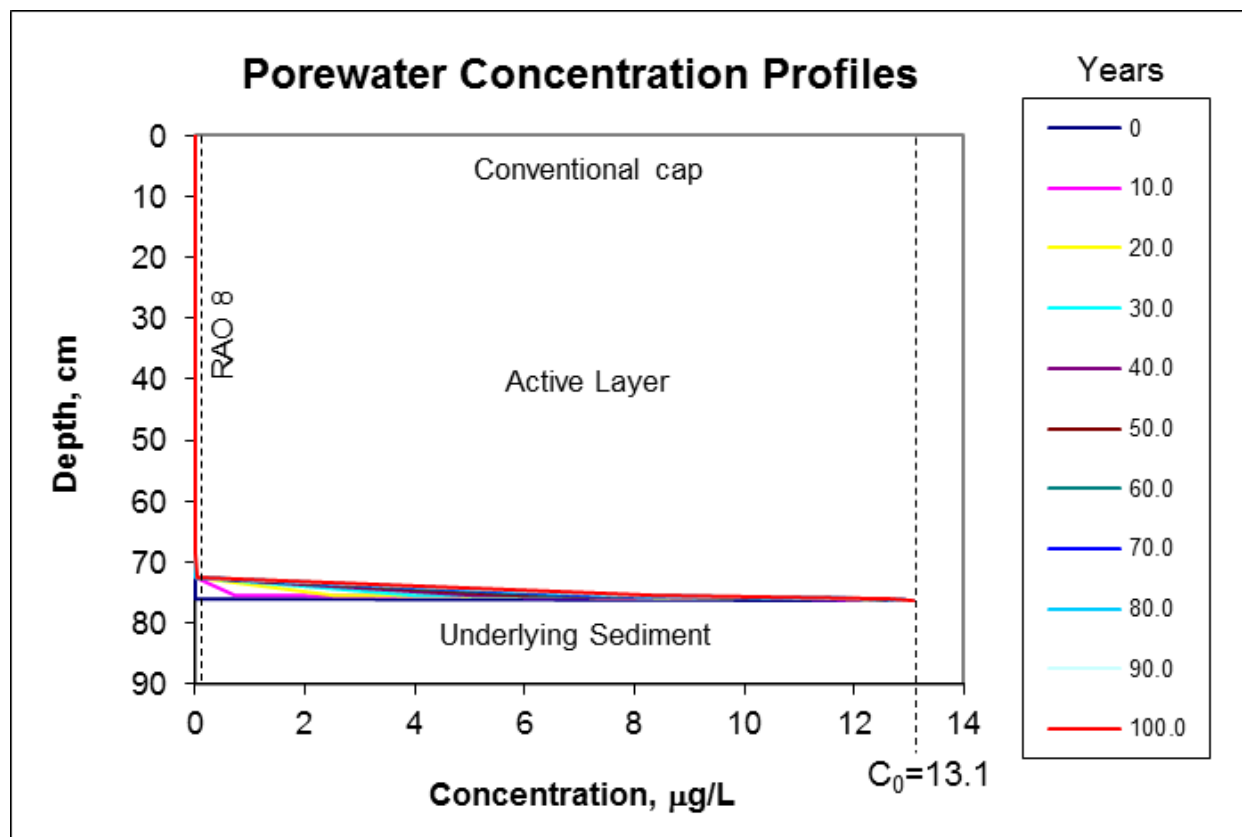


- Porewater concentration at surface of cap reaches RAO 8 PRG of 64 $\mu\text{g/L}$ at ~66 years.

Preliminary Model Results: DDx Cap Scenario 1

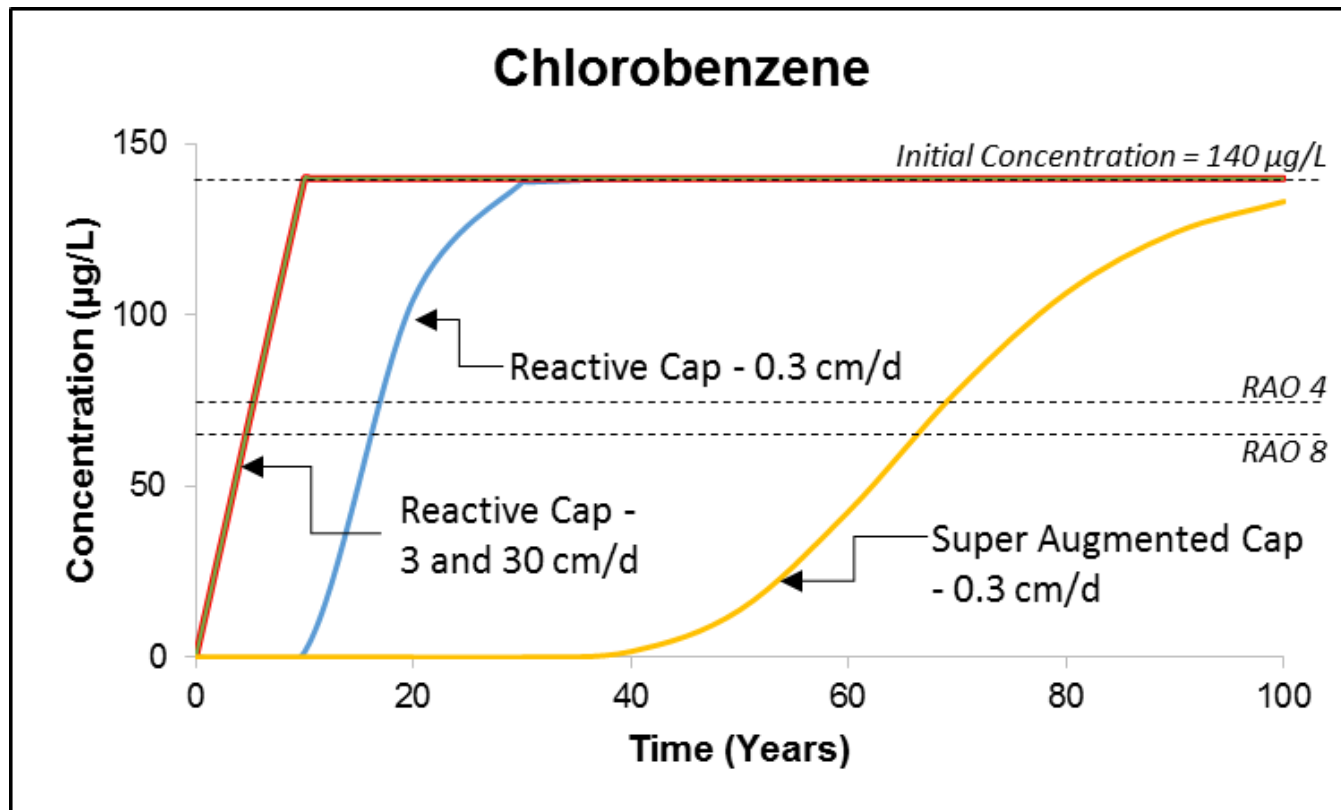


Preliminary Model Results: DDx Cap Scenario 2

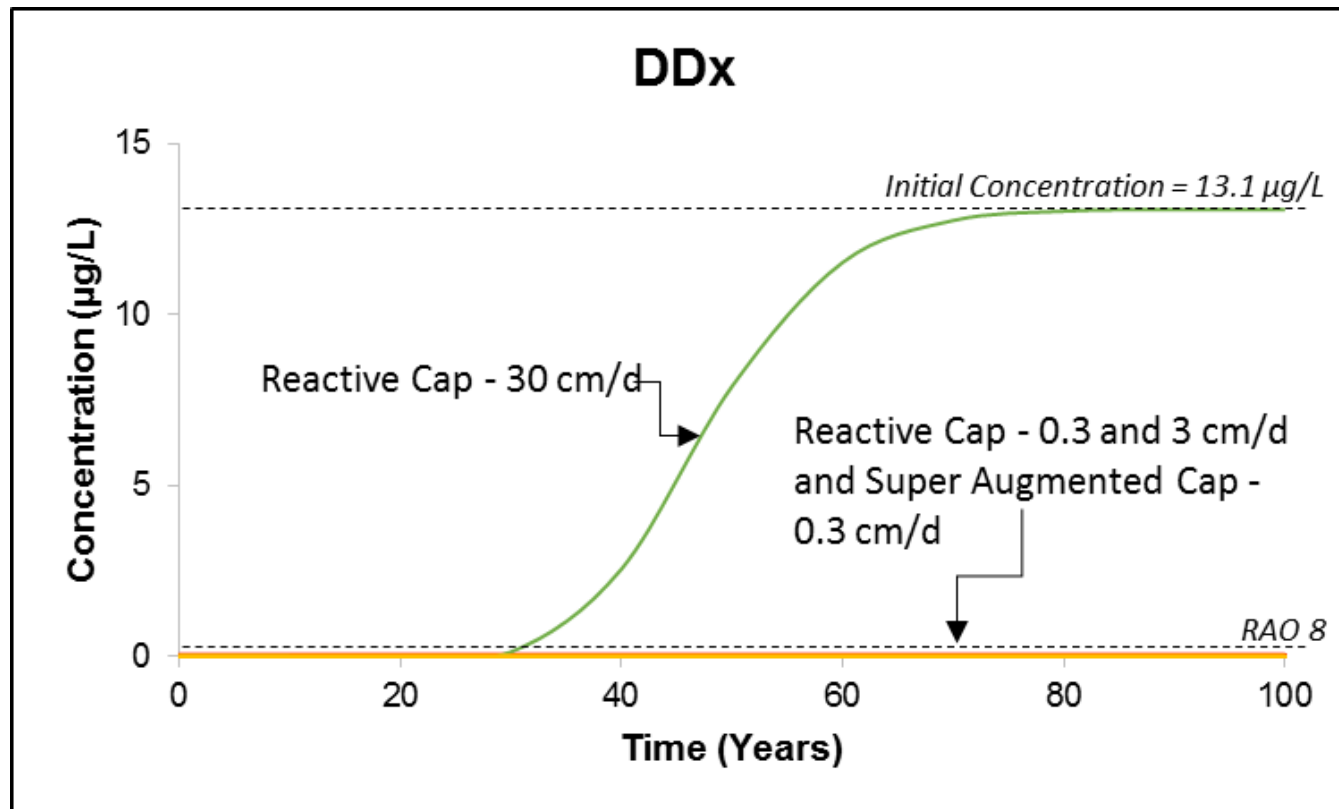


- Porewater concentration near surface of cap does not reach RAO 8 PRG of $0.001 \mu\text{g/L}$ for the design period of 100 years.

Preliminary Model Results: Chlorobenzene at cap-surface water interface



Preliminary Model Results: DDx at cap-surface water interface



Preliminary Results at 100 years

- Cap Scenario 1 – Reactive Cap:
 - Complete chlorobenzene breakthrough occurs for all seepage velocities
 - Complete DDx breakthrough for maximum seepage velocity only
- Cap Scenario 2 – Significantly Augmented Cap:
 - More than 90% breakthrough for Chlorobenzene at 100 years
 - DDx fully contained

Preliminary Results at PRG Values

Type of Cap	Seepage Velocity (cm/d)	Chlorobenzene	DDx
Reactive Cap	0.3	RAO 8 exceeded @~17 years	No exceedance
Reactive Cap	3	RAO 8 exceeded @~1.7 years	No exceedance
Reactive Cap	30	RAO 8 exceeded @~62 days	RAO 8 exceeded @~23 years
Significantly Augmented Cap	0.3	RAO 8 exceeded @~66 years	No exceedance

Preliminary Conclusions

- For both contaminants modeled using site specific worst case scenario (i.e. max observed concentration at the Site, 30 cm/d seepage velocity), the model shows cap failure prior to 100 years for the Reactive Cap
- Chlorobenzene concentrations at cap-surface water interface reach PRG values with both caps
- DDx concentrations at cap-surface water interface do not reach PRG values with Significantly Augmented Cap
- Chemical degradation in Significantly Augmented Cap had minimal effects on contaminant breakthrough during sensitivity analyses
 - Chlorobenzene concentration at the surface at 100 years is reduced but is still above RAO 8 concentration
 - DDx is fully contained with and without degradation